# Gravitational Bending of Light

(attachment in essay: ***Relativity Replaced–Ether found around Earth***)

**By**

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By doing the transformation $r = 1/u$, equation (2.80)* becomes:

$$\frac{d^2u}{d\varphi^2} + u = 2\alpha\left[u^2 + \left(\frac{du}{d\varphi}\right)^2\right] \qquad (2.81)^*$$

Where $\alpha \equiv \frac{GM}{C_\infty^2}$ and $M$ the attracting mass, equation (2.81)* represents with a good approximation a hyperbolic path for light ray:

The second member of (2.81)*, in the case of the Sun, is negligible compared with the terms of the first member; thus we can write, for the moment, the second member equal to zero:

$$\frac{d^2u_{zero}}{d\varphi^2} + u_{zero} = 0 \quad \text{(zero order equation)}$$

The solution of this equation is a straight line:

$$u_{zero} = K \cdot \cos\varphi \quad \text{(zero order solution)}$$

where K is the constant of the integration and angle φ is measured from the direction of maximum *u* or the same thing, the minimum r (i.e. for φ = 0 $r = r_o$ = minimum and thus $K=1/r_o$), thus we get

$$u_{zero} = (1/r_0)\cdot\cos\varphi$$

Substituting, now the last expression for $u_{zero}$ into the second member of our initial equation (2.81)*, it becomes:

$$\frac{d^2u_{FIRST}}{d\varphi^2} + u_{FIRST} = \frac{2\alpha}{r_o^2} \quad \text{(first order equation)}$$

The solution of the last equation gives the first order solution of our initial equation (2.81)*:

$$u_{FIRST} = \frac{1}{r} = \frac{2\alpha}{r_o^2} + K'\cdot\cos\varphi \quad \text{(first order solution of the equation (2.81)*)}$$

This first order solution represents a conic section (hyperbola) and $K'$ is the integration constant (to be determined): for $\varphi = 0$ , $r = r_o$ and thus $K' = \frac{1}{r_o}\left(1 - \frac{2\alpha}{r_o}\right)$ ; thus the first order solution becomes

$$u_{FIRST} = \frac{1}{r} = \frac{2\alpha}{r_o^2} + \frac{1}{r_o}\left(1 - \frac{2\alpha}{r_o}\right) \cdot \cos\varphi$$

This last equation gives $u_{FIRST} = 0$ or $r = \infty$ when $\varphi = \varphi_\infty$,

$$\cos\varphi_\infty = -\frac{(2\alpha / r_o)}{(1 - 2\alpha / r_o)} \approx -\frac{2\alpha}{r_o},$$

thus we get for $\varphi_\infty = \frac{\pi}{2} + \frac{2\alpha}{r_o}$ .

The angle of the two asymptotes of the hyperbola minus π, gives the deflection of the light ray:

$$D = (2\varphi_\infty - \pi) \approx \frac{4\alpha}{r_o} \equiv \frac{4GM}{r_o C_\infty^2} \qquad (2.82)*$$

($r_o$ is the closest distance of the path of light from the attracting central mass $M$ ).

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*This numbering of relations is referred in the Text of the essay: "***Relativity Replaced- Ether found around Earth***"